It's a Go

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The Electrical Power Distribution Control Team takes on the task of determining power failures throughout the Orbiter. The Displays and Controls Team takes on the task of determining distribution, circuit breakers, and switch failures that might occur on the Orbiter or displays that stop working. This paper will identify the circuit packages I have put together for the D&C group, the redesigning of a Hybrid Driver Controller box, and the web designing the Displays and Controls website for easier access to information which can range from indicators to switches.

I. Introduction

For the last four months I have been working with the Electrical Power Distribution Controls Team and the Displays and Controls Team of the Orbiter. The Electrical Power Distribution Team finds solutions to all the power problems the Orbiter might have during its mission or problems found during testing of its components. The Displays and Controls Team finds solutions to problems that occur with switches or controls that stop working during the mission or at testing at the Orbiter Processing Facility, Vehicle Assembly Building, or at the Pads.

I have been working closely with these two teams and have accomplished making circuit packages, which are packages for circuits that have failed numerous times. It will shorten the period of which members of the team would have to go looking through schematics to find out where this switch goes and what it controls. These packages will have what the switch connects to, the switch function, and all the part numbers and schematics.

The Displays and Controls website I have been working on for a couple of weeks. It will allow the team members to go onto any panel and find out the part number of any switch, the schematic reference numbers, the zone they are located on inside of the schematic and what the switch controls. This is similar to the circuit packages but this website is for all the components and not just ones that have failed in the past. This website is a lean initiative website because the members will not have to search through schematics but instead just go to the website and obtain their answer.

For the Electrical Power Distribution Team, I have been given a project to redesign a Hybrid Load Controller Box to better fit the technology we have available today.

II. Circuit Packages

These packages were made for equipment on the Orbiter that has failed numerous times. They were made to reduce time spent looking through schematics to see what the circuit is powering and operating. The packages will include:

- Part numbers of various components
- A small representation of what the circuit is powering and operating
- Panel on which the component is located and the panel number
- Description of what the component does
- The pins and connections of the circuit.

A. Circuit Schematic

From Figure 1, this is the basic schematic of what the Air Data Probe switch powers and controls. From the Air Data Probe switch to the left, when it is in the Stow position, it will send power to the Air Data Probe Stow Switch and when this switch is on Enable, it sends power to the Right Probe Motor Number One and Number Two Control.

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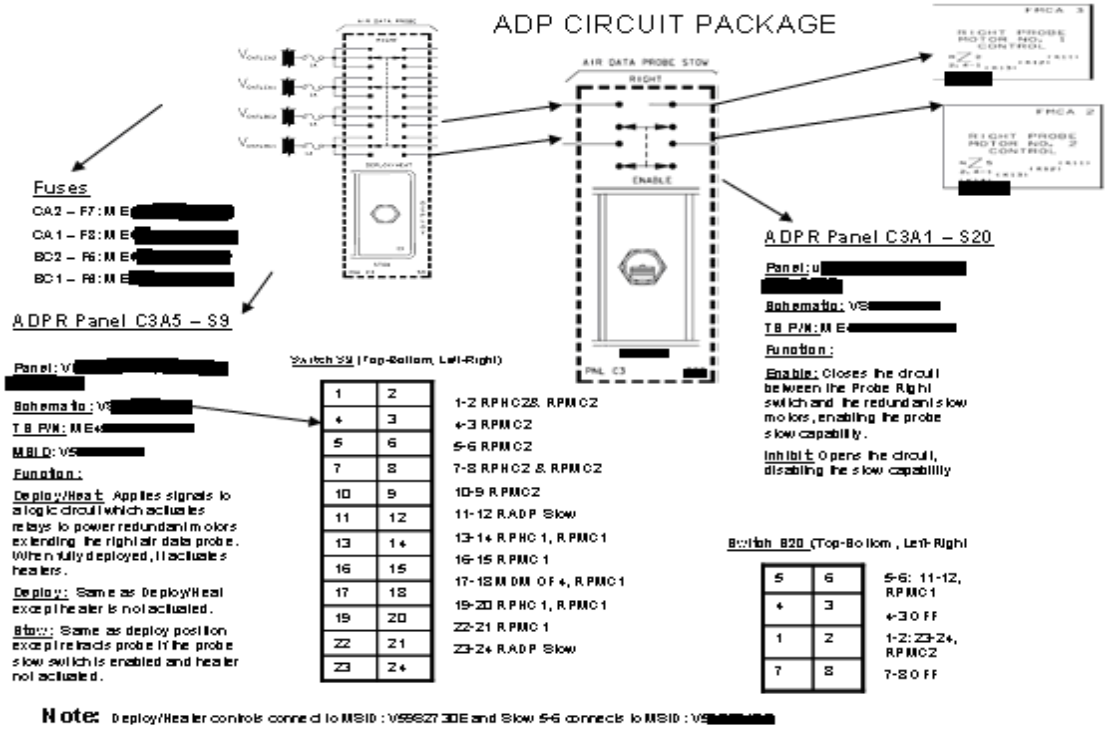

Figure 1. Air Data Probe Circuit Package

B. Description of the Switches

It can be seen that I have marked what panel the switch belongs too and its associated number for the switch (see Figure 1). From there it can be seen that each Orbiter Vehicle 103-105 has a specific dash number associated to its panel number. The schematic from where the information has been taken has been referenced along with the part number of the switch. I decided from there to put a brief description of what the switch does because any individual who decided to look at this package, they would have a brief overview of what the switch is doing in each of its positions.

C. Switch Configuration

The table shown above (see Figure 1) shows the Air Data Probe switch and its switch configuration. This table represents what each pin on the switch connects to from top to bottom and left to right. It was put in the package to save time from going to the schematic and finding its configuration. I have designed other circuit packages and these are:

- Drag Chute
- General Personal Computer
- Nose Wheel Steering

III. Designing the D&C Website

This website was developed to ease the use of having to go to schematics to find information for certain types of equipment. This website would tell the person what each switch does, to see what the part looks like, the parts' location on the schematic and assembly drawing, and part numbers. Putting together this website is time consuming but after it is all done, it should lessen the time spent looking through schematics and assembly drawings. It will make troubleshooting and root cause investigating more efficient and with faster turnaround.

IV. Redesign of the AHLC Box Number

I was given the task of taking the AHLC Box Number Two and Hybrid Drivers and redesigning them to make a box that would fit the technology of today. Redesigning this box would get rid of all of the Hybrid Drivers; a reduction in size and weight, and have more parts that can be off the shelf to reduce the amount of special parts that need to be built. The AHLC Box Number Two is made up of over 200 Hybrid Drivers with at least four Hybrid Drivers on each module. There are five types of Hybrid Drivers and they are:

- **Type I**: 0.15 Amp Power Switching at 28 Volt
  - Normally used as a 28 Volt discrete command input
- **Type II**: 0.05 Amp Logic Switching at 28 Volt with time delay
  - 40msec, 1 sec, and 4 sec delay
  - Used as a 28 Volt discrete command input
- **Type III**: 5 Amp Power Switching at 28 Volts
  - Most popular Drivers
  - Power control to heaters, relays, valves, and others
- **Type IV**: 5 amps Negative Bus switching
  - Switching control from a load to the 28 Volt return terminal
  - Normal use on critical heater circuit
- **Type V**: 0.05 Amp power switch for temperature controlled.
  - Switching operation is controlled by the temperature sensor

The box can weigh between 50 and 65 pounds. I wasn't given any suggestions on how to redesign it but came up with ideas that would bring the box to the 21st century instead of the 20th century. The ideas that I came up with were:

- Make the box smaller and weigh less.
- Introduce an All Circuit Board Box
- 1553 data bus Card
- Processor Card
- Consolidate a number of power switching transistors onto one card called the Load Driver Card
- Power supply card for the data bus and processor card
- The box will have easier extraction of the circuit cards
- Backplane
- New heat sinking.

A. Box Size and Weight

The original AHLC Box is 20 inches long, almost 8 inches high, and 12 inches wide. I introduced reducing the size of the box to 9 to 12 inches long, 7 to 10 inches high, and 10 to 13 inches wide (see Figure 2.). This could be done by the design of an all circuit card box; using a backplane will reduce the amount of wires needed to connect the cards together. A newer metal has been developed that is lighter in weight and half as dense as steel and proposed to be the new metal from which the box will be made.

Figure 2. AHLC Box Number Two

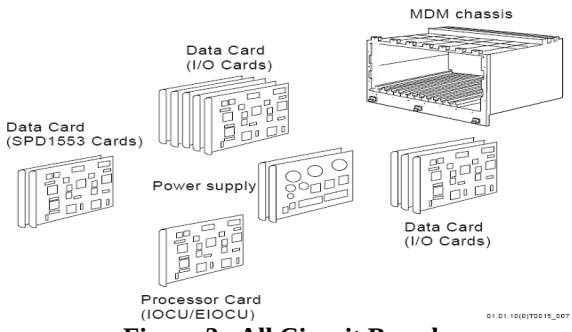

Figure 3. All Circuit Board

B. All Circuit Board Box

This box will not be like the original style of the AHLC Box Number Two. It will only have circuit cards (see Figure 3.) and have no modules like that of Box Number Two. This box will include a 1553 data bus card, power supply card, processor card, and the load driver card which is the Data Card displayed on Figure 3.

The 1553 data bus card will replace the resistors used in the modules. The resistors are used for the instrument data.

The 1553 data bus is the communication link with other hardware and it will:

- Receive the commands
- Provide feedback on each channel

The processor card will take the incoming signal and outgoing signal and distribute it to the specified channel. The power supply card, (see Figure 3.), is added to the box to power the 1553 data bus card and the processor card. This power supply card is required because the input voltage is 28 volts and 1553 card and the processor card will need between five and ten volts to make the cards active.

C. Load Driver Card

From Figure 3, it can be seen that the Data Card represents the Load Driver Card inside of the box. It consists of a number of power transistors. The Load Driver Card will consist of a mixture of 32 channels with an example of 16 being discrete channels and 16 being power channels. There will be two configurations of boxes with the specified Load Driver Cards.

- 4 Load Driver Cards – 128 Channels
- 10 Load Driver Cards – 320 Channels

When the processor card takes the incoming and outgoing signal, it will find out what channel it needs to go to and send it to the specified channel on the load driver card which will then turn on the power transistors to operate what specified equipment it needs to operate.

D. Circuit Card Extraction, Backplane, and Heat Sinking.

This box will be designed so that if a problem does ever occur with a card, it will be able to be easily extracted for analysis (see Figure 4.). The backplane of the box will be a printed circuit board which will connect all the necessary components up together without the use of wires (see Figure 5.). Heat sinking will help eliminate some of the heat produced by the cards. By taking a thin square piece of metal and attaching it to the backside of the card and fitting the slots. The card will be placed in the slot with the heat sink attached to it; a lot of the heat created should be absorbed by this layer of metal and sent directly to the box, with this box being attached to a cooling plate.

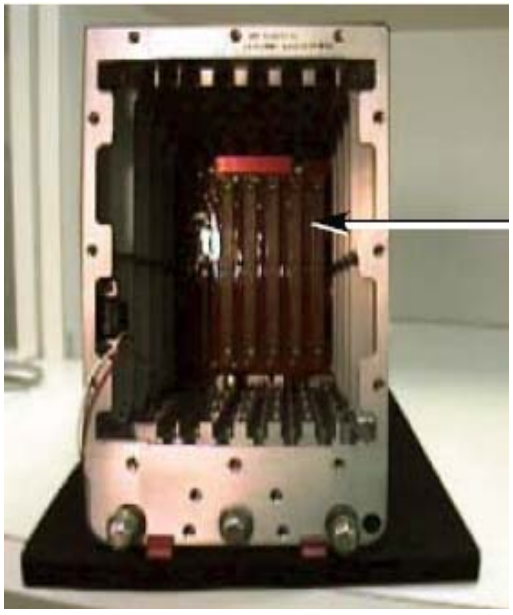

Figure 4. Backplane

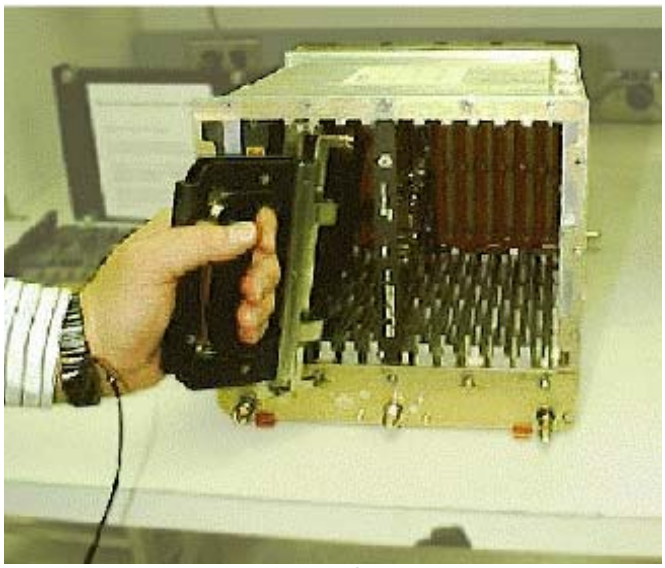

Figure 5. Extraction of the Circuit Cards

V. What This Means for the Teams

All the topics I have talked about ties into any mission that the Orbiter accomplished. The circuit packages will help in any failure because if a major failure does occur, the team can automatically pull up the package that is linked to the failed part and automatically have all the information on hand to find out what the switch connects with and what exactly it does. This will save time when a mission is going on because it will allow the team to determine the potential cause for the failure instead of going through many schematics trying to figure out what exactly this switch connects with and what it is doing. Even though the Orbiter does not have spare parts on board for failures, it would at least tell the team what exactly this part will affect inside of the Orbiter. The team can give the details to the NASA contractor as to the health of the remainder of the system.

The redesign of the AHLC Box Number Two could possibly make the box weigh less which would allow for more things to be added to the Orbiter if required. This box would bring the 21st Century to the Orbiter by using more up-to-date components and more off the shelf components, instead of paying companies to manufacturer these components. If the box were to fail, the extraction of the cards would be quick and easy with almost little to no wires to attach to the cards. Little to no wires would reduce weight and allow for fewer accidents in testing the box and putting it back together incorrectly.

The safety of this redesign will meet all criteria needed by NASA which will include:

- Vibration
- Thermal
- Functional

The website would allow the team to move quickly to finding a part number and referencing to what schematic the part goes to and where on the schematic the part is. This will lessen the time involved in searching through the shuttle handbook to find the panel number, then going to another website to look for the schematic, then looking through the schematic. This site will have the schematic to look in, the part number, and a short sentence on what the switch does.

VI. Conclusion

Through my time spent here, I have helped build these packages, redesign the AHLC Box Number Two, and build on to the team's website. It has been a good four months well spent learning how things work with NASA. These packages will help if a failure should ever occur with the certain packages that have been done. The redesign of this box will do good things if ever implemented; take the Orbiter more into the future rather then being stuck in the 70s. The website will be a great success once it is finished. I would like to say though that this was a very good experience and especially since I saw my first shuttle launch too. I have learned quite a bit and hope to take this information further into my career with what I do and what employer I choose to work for. If I ever have the chance to do this again, I shall take the challenge head on and encourage people to take up an internship out here. There are so many things to see and always new information to learn no matter what it is.